

1 CLAIMS:

2 1. A method of masking and etching a semiconductor substrate
3 comprising:

4 forming a layer to be etched over a semiconductor substrate;

5 forming an imaging layer over the layer to be etched;

6 removing selected regions of the imaging layer to leave a pattern
7 of openings extending only partially into the imaging layer; and

8 after the removing, etching the layer to be etched using the
9 imaging layer as an etch mask.

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11 2. The method of claim 1 wherein the imaging layer is organic.

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13 3. The method of claim 1 wherein the imaging layer comprises
14 organic photoresist.

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16 4. The method of claim 1 wherein the imaging layer consists
17 essentially of organic photoresist.

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19 5. The method of claim 1 wherein the imaging layer consists
20 essentially of a single, homogeneous layer.

1 6. The method of claim 1 wherein the etching comprises:
2 blanket etching the imaging layer with an etch chemistry that is
3 substantially selective to the layer to be etched to outwardly expose the
4 layer to be etched through mask openings in the imaging layer; and
5 after the blanket etching, etching the layer to be etched through
6 the mask openings using an etch chemistry that is substantially selective
- to the imaging layer.

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9 7. The method of claim 1 wherein the etching comprises:
10 blanket etching the imaging layer and the layer to be etched using
11 an etch chemistry that is substantially selective to the imaging layer, the
12 blanket etching first etching through the opening bases effective to
13 expose the layer to be etched and then etching selectively into the layer
14 to be etched

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16 8. The method of claim 1 wherein the removing comprises ion
17 implanting the selected regions.

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19 9. The method of claim 1 wherein the removing comprises ion
20 implanting the selected regions to change solvent solubility of implanted
21 regions versus non-implanted regions of the imaging layer, and wherein
22 the removing further comprises wet solvent processing.

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1 10. The method of claim 1 wherein the removing comprises
2 exposing the selected regions to actinic energy.

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4 11. The method of claim 1 wherein the removing comprises
5 exposing the selected regions to actinic energy to change solvent
6 solubility of implanted regions versus non-implanted regions of the
7 imaging layer, and wherein the removing further comprises wet solvent
8 processing.

9
10 12. An ion implant lithography method of processing a
11 semiconductor substrate comprising:

12 forming a layer to be etched over a semiconductor substrate;

13 forming an imaging layer over the layer to be etched;

14 ion implanting selected regions of the imaging layer to change
15 solvent solubility of implanted regions versus non-implanted regions of
16 the imaging layer, said ion implanting forming the implanted regions to
17 have innermost peak implant concentrations which are spaced
18 elevationally outward of the layer to be etched;

19 removing the ion implanted regions of the imaging layer to leave
20 a pattern of openings extending only partially into the imaging layer;
21 and

22 after the removing, etching the layer to be etched using the
23 imaging layer as an etch mask.
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1 13. The method of claim 12 wherein the imaging layer is
2 organic.

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4 14. The method of claim 12 wherein the imaging layer comprises
5 organic photoresist.

6
7 15. The method of claim 12 wherein the imaging layer consists
8 essentially of a single, homogeneous layer.

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10 16. The method of claim 12 wherein the ion implanting
11 comprises implanting hydrogen ions.

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13 17. The method of claim 12 wherein the ion implanting
14 comprises implanting helium ions.

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16 18. The method of claim 12 wherein the ion implanting forms
17 the innermost peak implant concentrations to be spaced elevationally
18 outward of the layer to be etched by about 50 Angstroms to
19 about 5000 Angstroms.

1 19. The method of claim 12 wherein the ion implanting forms
2 the innermost peak implant concentrations to be spaced elevationally
3 outward of the layer to be etched by about 200 Angstroms to
4 about 2000 Angstroms.

5
6 20. The method of claim 12 wherein the ion implanting forms
7 the innermost peak implant concentrations to be spaced elevationally
8 outward of the layer to be etched by about ⁴⁰⁰~~200~~ Angstroms to
9 about ~~2000~~ Angstroms. ^{6/20/00}

10 ^{800/00 6/20/00}
11 21. The method of claim 12 wherein the removing comprises
12 wet solvent etching.

1 22. An ion implant lithography method of processing a
2 semiconductor substrate comprising:

3 forming a layer to be etched over a semiconductor substrate;

4 forming an imaging layer of a selected thickness over the layer
5 to be etched;

6 ion implanting selected regions of the imaging layer to change
7 solvent solubility of implanted regions versus non-implanted regions of
8 the imaging layer, said selected regions not extending entirely through
9 the imaging layer thickness;

10 removing the ion implanted regions of the imaging layer to leave
11 a pattern of openings extending only partially into the imaging layer;
12 and

13 after the removing, etching the layer to be etched using the
14 imaging layer as an etch mask.

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16 23. The method of claim 22 wherein the imaging layer is
17 organic.

18
19 24. The method of claim 22 wherein the imaging layer comprises
20 organic photoresist.

1 25. The method of claim 22 wherein the ion implanting forms
2 the selected regions to have innermost bases which are spaced
3 elevationally outward of the layer to be etched by about 50 Angstroms
4 to about 5000 Angstroms.

5
6 26. The method of claim 22 wherein the ion implanting forms
7 the selected regions to have innermost bases which are spaced
8 elevationally outward of the layer to be etched by about 200 Angstroms
9 to about 2000 Angstroms.

10
11 27. The method of claim 22 wherein the ion implanting forms
12 the selected regions to have innermost bases which are spaced
13 elevationally outward of the layer to be etched by about ⁴⁰⁰200 Angstroms
14 to about ~~2000~~ Angstroms.

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17 28. The method of claim 22 wherein the etching comprises:
18 blanket etching the imaging layer with an etch chemistry that is
19 substantially selective to the layer to be etched to outwardly expose the
20 layer to be etched through mask openings in the imaging layer; and
21 after the blanket etching, etching the layer to be etched through
22 the mask openings using an etch chemistry that is substantially selective
23 to the imaging layer.
24

1 29. The method of claim 22 wherein the etching comprises:
2 blanket etching the imaging layer and the layer to be etched using
3 an etch chemistry that is substantially selective to the imaging layer, the
4 blanket etching first etching through the bases of the openings effective
5 to expose the layer to be etched and then etching selectively into the
6 layer to be etched

1 30. An ion implant lithography method of processing a
2 semiconductor substrate comprising:

3 forming a layer to be etched over a semiconductor substrate;

4 forming an imaging layer over the layer to be etched;

5 ion implanting selected regions of the imaging layer to change
6 solvent solubility of implanted regions versus non-implanted regions of
7 the imaging layer, said ion implanting forming the implanted regions to
8 have innermost peak implant concentrations which are spaced
9 elevationally outward of the layer to be etched;

10 removing the ion implanted regions of the imaging layer to leave
11 a pattern of openings extending only partially into the imaging layer;

12 after the removing, blanket etching the imaging layer with an etch
13 chemistry that is substantially selective to the layer to be etched to
14 outwardly expose the layer to be etched through mask openings in the
15 imaging layer; and

16 after the blanket etching, etching the layer to be etched through
17 the mask openings using an etch chemistry that is substantially selective
18 to the imaging layer.

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20 31. The method of claim 30 wherein the blanket etching
21 comprises O₂ plasma.
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1 32. The method of claim 30 wherein the imaging layer is
2 organic.

3
4 33. The method of claim 30 wherein the imaging layer comprises
5 organic photoresist.

6
7 34. The method of claim 30 wherein the ion implanting forms
8 the innermost peak implant concentrations to be spaced elevationally
9 outward of the layer to be etched by about 50 Angstroms to
10 about 5000 Angstroms.

11
12 35. The method of claim 30 wherein the ion implanting forms
13 the innermost peak implant concentrations to be spaced elevationally
14 outward of the layer to be etched by about 200 Angstroms to
15 about 2000 Angstroms.

16
17 36. The method of claim 30 wherein the ion implanting forms
18 the innermost peak implant concentrations to be spaced elevationally
19 outward of the layer to be etched by about ⁴⁰⁰~~200~~ Angstroms to
20 about ~~2000~~ Angstroms.

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1 37. An ion implant lithography method of processing a
2 semiconductor substrate comprising:

3 forming a layer to be etched over a semiconductor substrate;

4 forming an imaging layer over the layer to be etched;

5 ion implanting selected regions of the imaging layer to change
6 solvent solubility of implanted regions versus non-implanted regions of
7 the imaging layer, said ion implanting forming the implanted regions to
8 have innermost peak implant concentrations which are spaced
9 elevationally outward of the layer to be etched;

10 removing the ion implanted regions of the imaging layer to leave
11 a pattern of openings extending only partially into the imaging layer,
12 the openings having bases which are spaced from the layer to be
13 etched; and

14 after the removing, blanket etching the imaging layer and the
15 layer to be etched using an etch chemistry that is substantially selective
16 to the imaging layer, the blanket etching first etching through the
17 opening bases effective to expose the layer to be etched and then
18 etching selectively into the layer to be etched.

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20 38. The method of claim 37 wherein the imaging layer is
21 organic.
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1 39. The method of claim 37 wherein the imaging layer comprises
2 organic photoresist.

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4 40. The method of claim 37 wherein the ion implanting forms
5 the innermost peak implant concentrations to be spaced elevationally
6 outward of the layer to be etched by about 50 Angstroms to
7 about 5000 Angstroms.

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9 41. The method of claim 37 wherein the ion implanting forms
10 the innermost peak implant concentrations to be spaced elevationally
11 outward of the layer to be etched by about 200 Angstroms to
12 about 2000 Angstroms.

13
14 42. The method of claim 37 wherein the ion implanting forms
15 the innermost peak implant concentrations to be spaced elevationally
16 outward of the layer to be etched by about ⁴⁰⁰~~200~~ Angstroms to
17 about ~~2000~~ Angstroms.

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